

Formation Acquisition Sensor for the TPF Mission

Jeff Tien, George Purcell
Jet Propulsion Laboratory, California Institute of Technology

Key Requirements

- Operating range: 16 m to 1 km
- Key performance requirements
 - bearing: 1 degree (1 s)
 - range: 50 cm (1 s)
 - instantaneous 4π coverage

Design and Features

Based upon the Autonomous Formation Flying (AFF) sensor

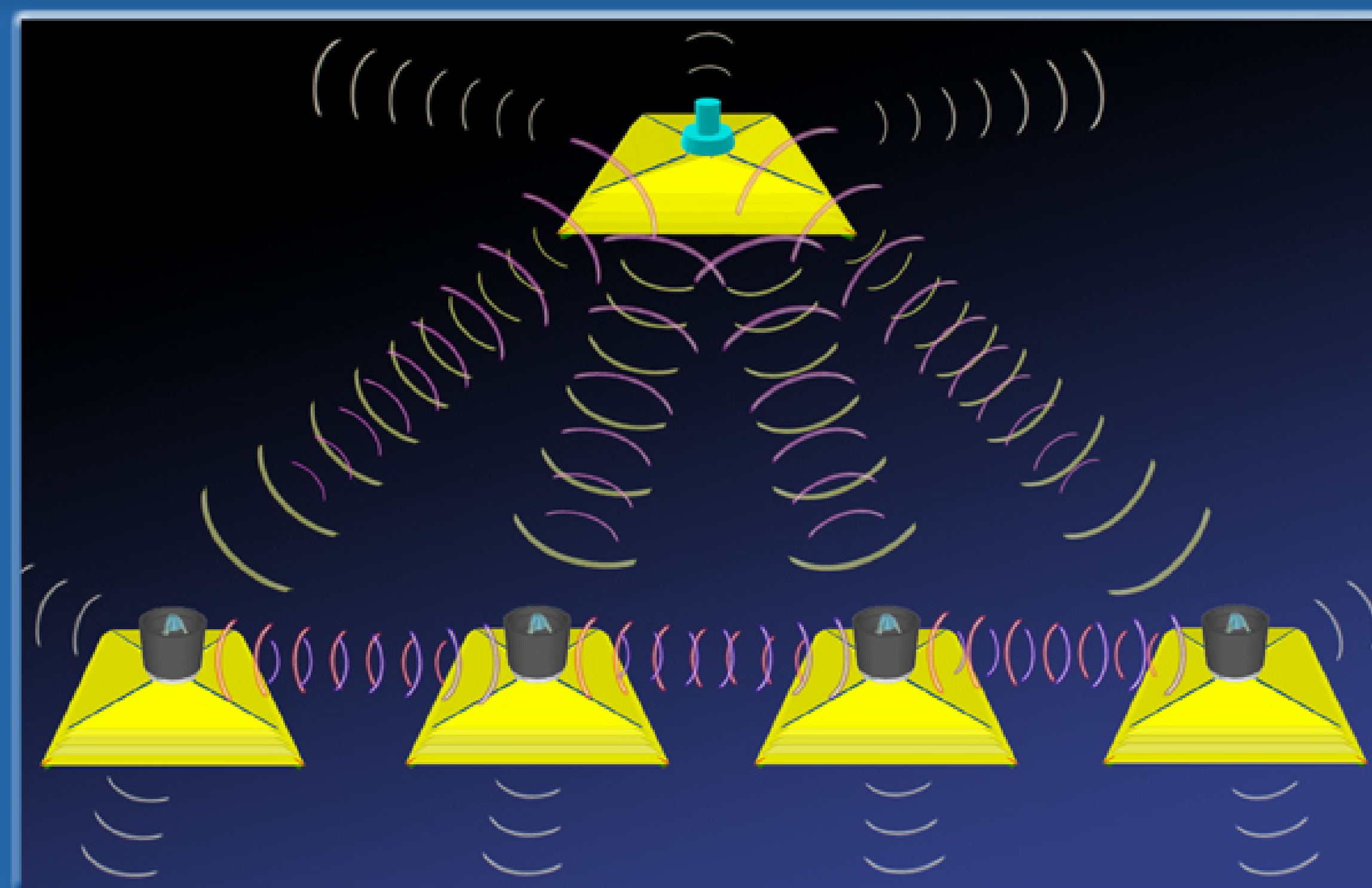
- Integrated range and bearing sensor
- Single backend processor and frequency reference
- Multiple wide-field antennas for 4π -steradian coverage
- Integrated radar capability for collision avoidance

A new signal structure will be developed to enable:

- An order of magnitude reduction in range error.
- Fine bearing angle measurement without the need for spacecraft rotation calibration maneuver.
- Simultaneous operation of multiple spacecraft
- Fast signal acquisition of less than one minute for multiple spacecraft operation.

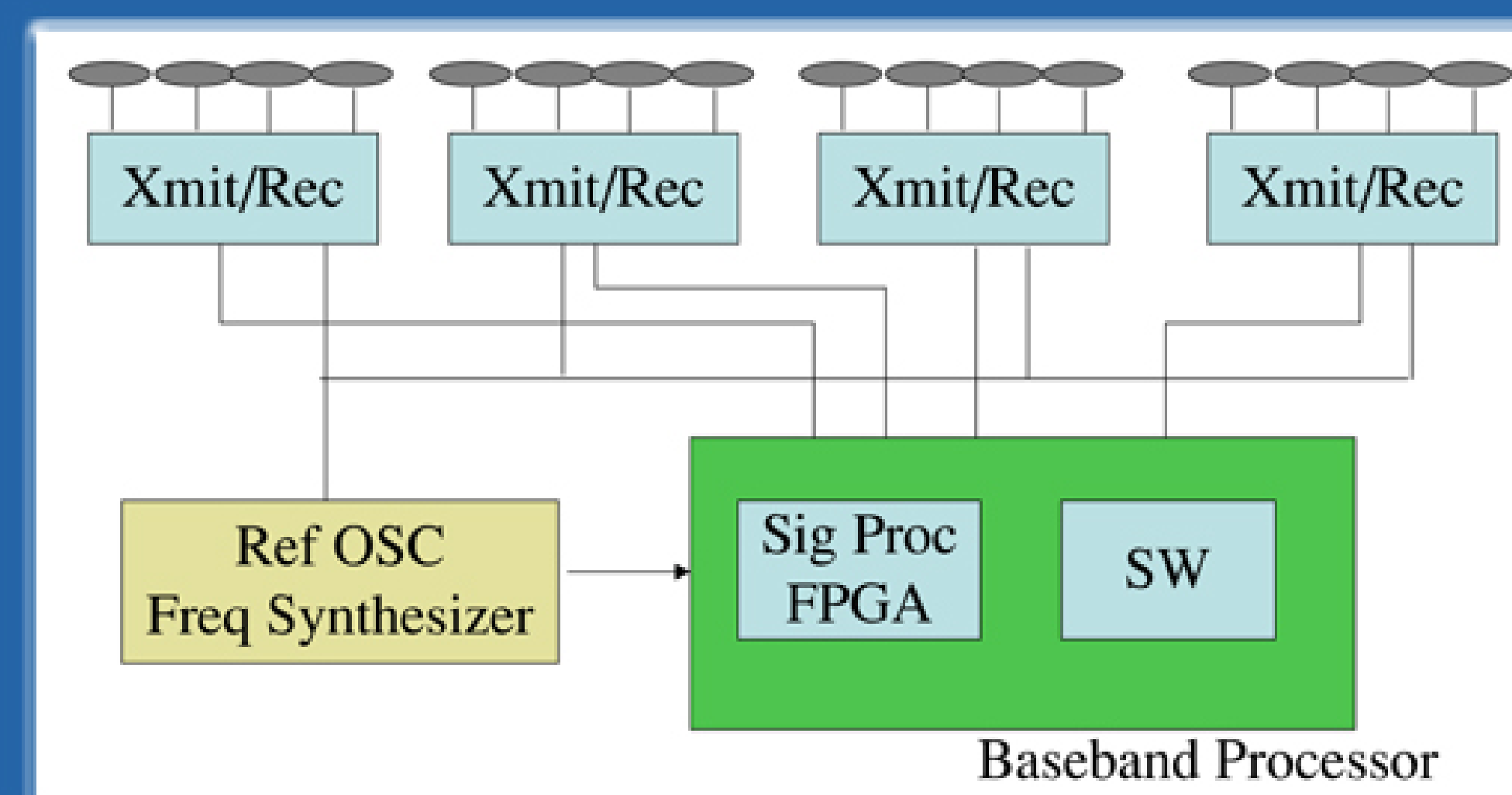
Potential future capabilities

- Integrated high-rate comm.
- Integrated medium FF sensor



Range and Bearing-angle Links

An integrated 4π -coverage range and bearing formation acquisition (coarse) sensor for the TPF Formation Flying Interferometer (FFI) mission.



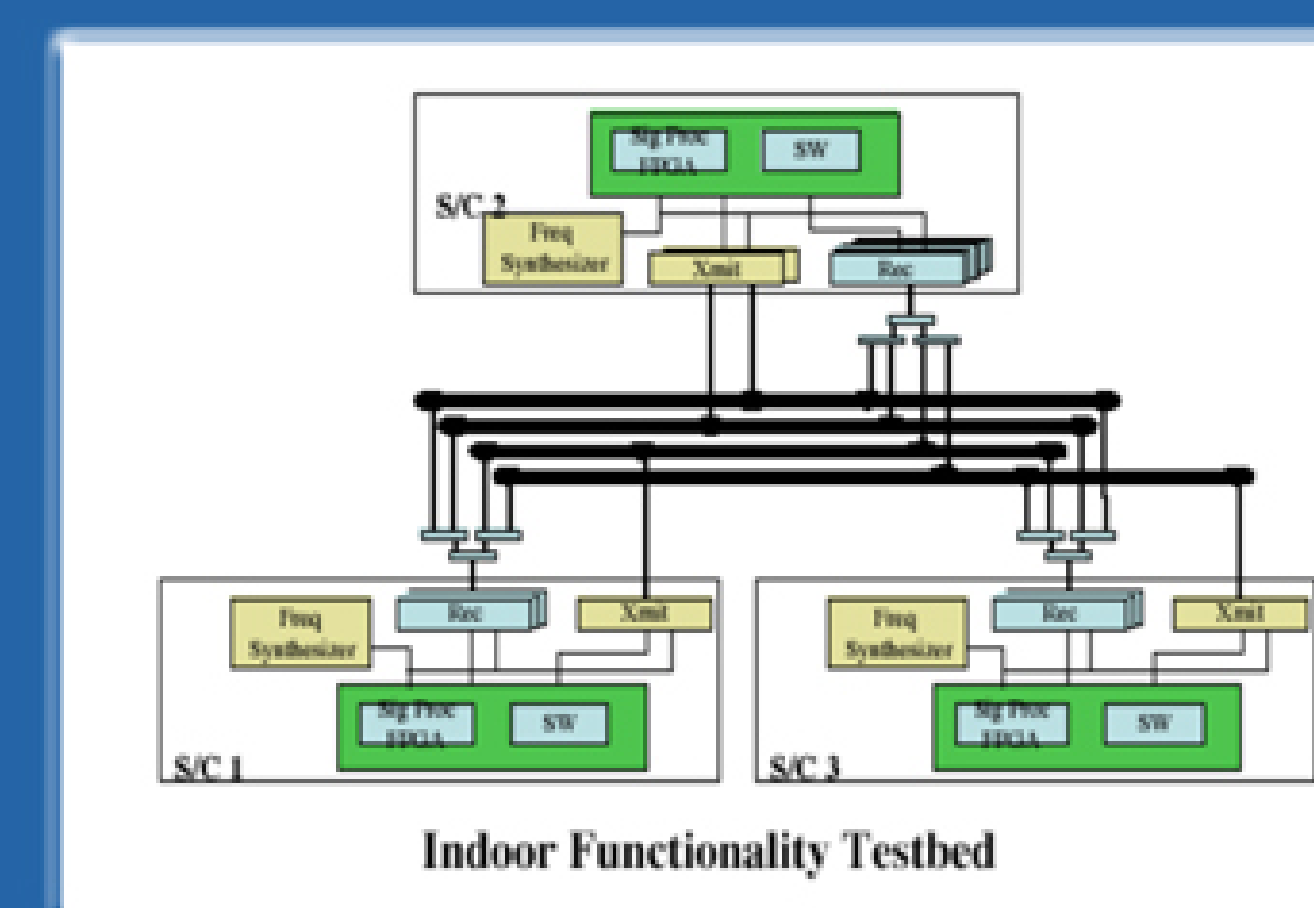
High-level functional block diagram



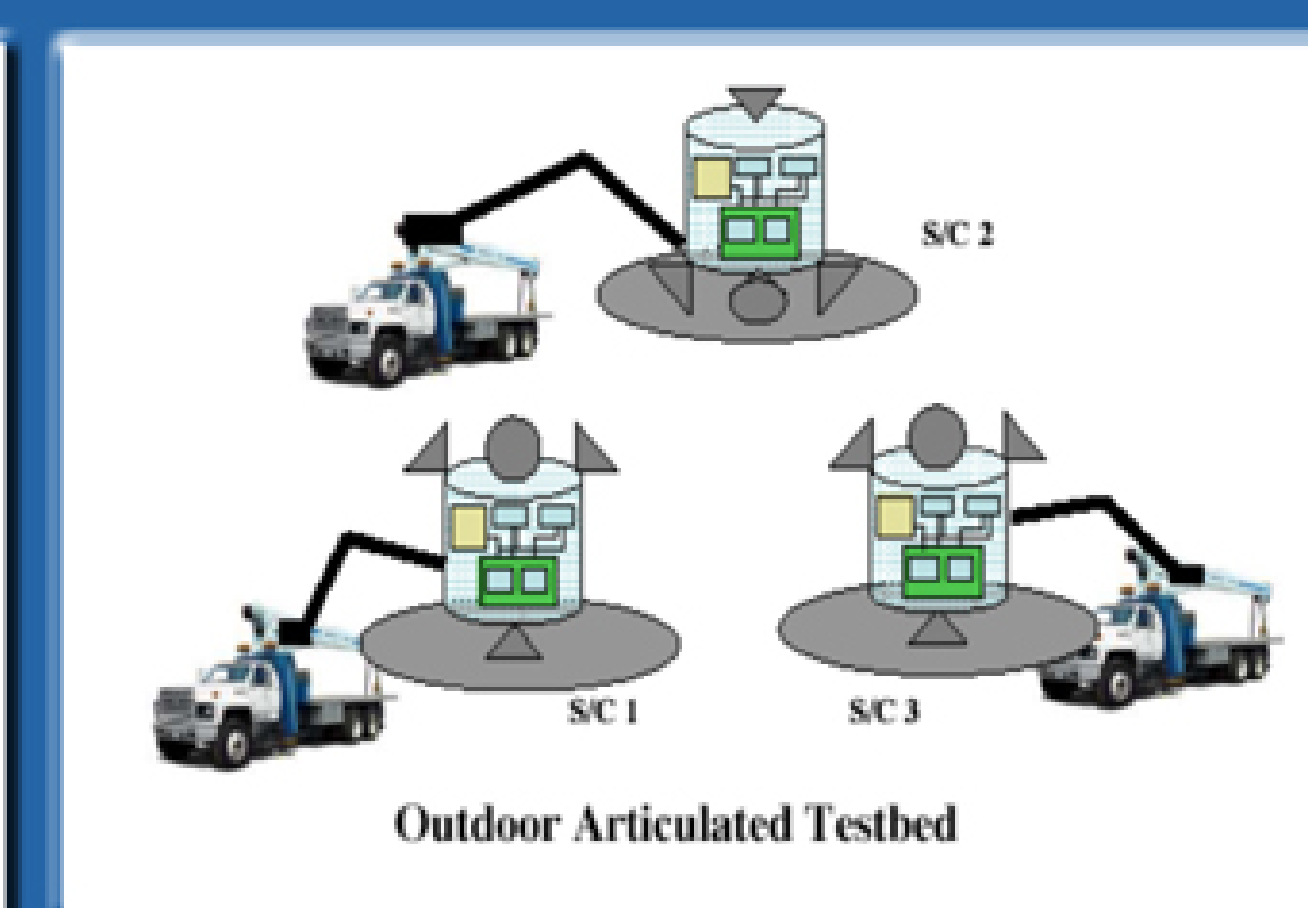
Prototype Signal Generator and Receiver

Approach

- Modify the AFF sensor to be used as the TPF acquisition sensor
- Indoor Functionality Testbed
 - HW & SW I&T
 - SW development platform
 - Functional verification
- Outdoor Articulated Testbed (with S/C mockup)
 - Validate range and bearing performance model
 - Demonstrate instantaneous coverage
 - Handover between antennas (2π -steradian)
 - Extrapolate to 4π through analysis



Indoor Functional Testbed



Outdoor Testbed

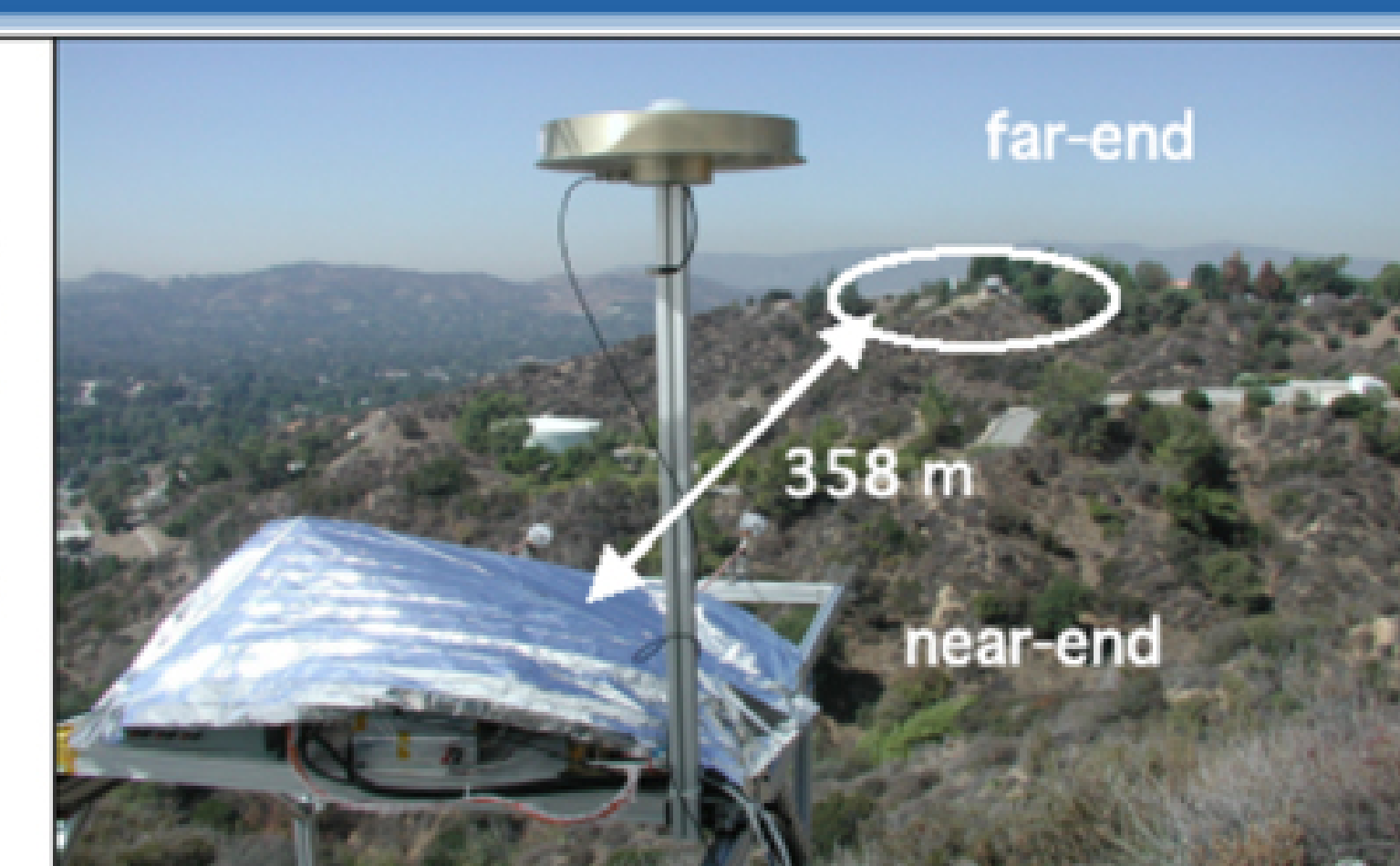
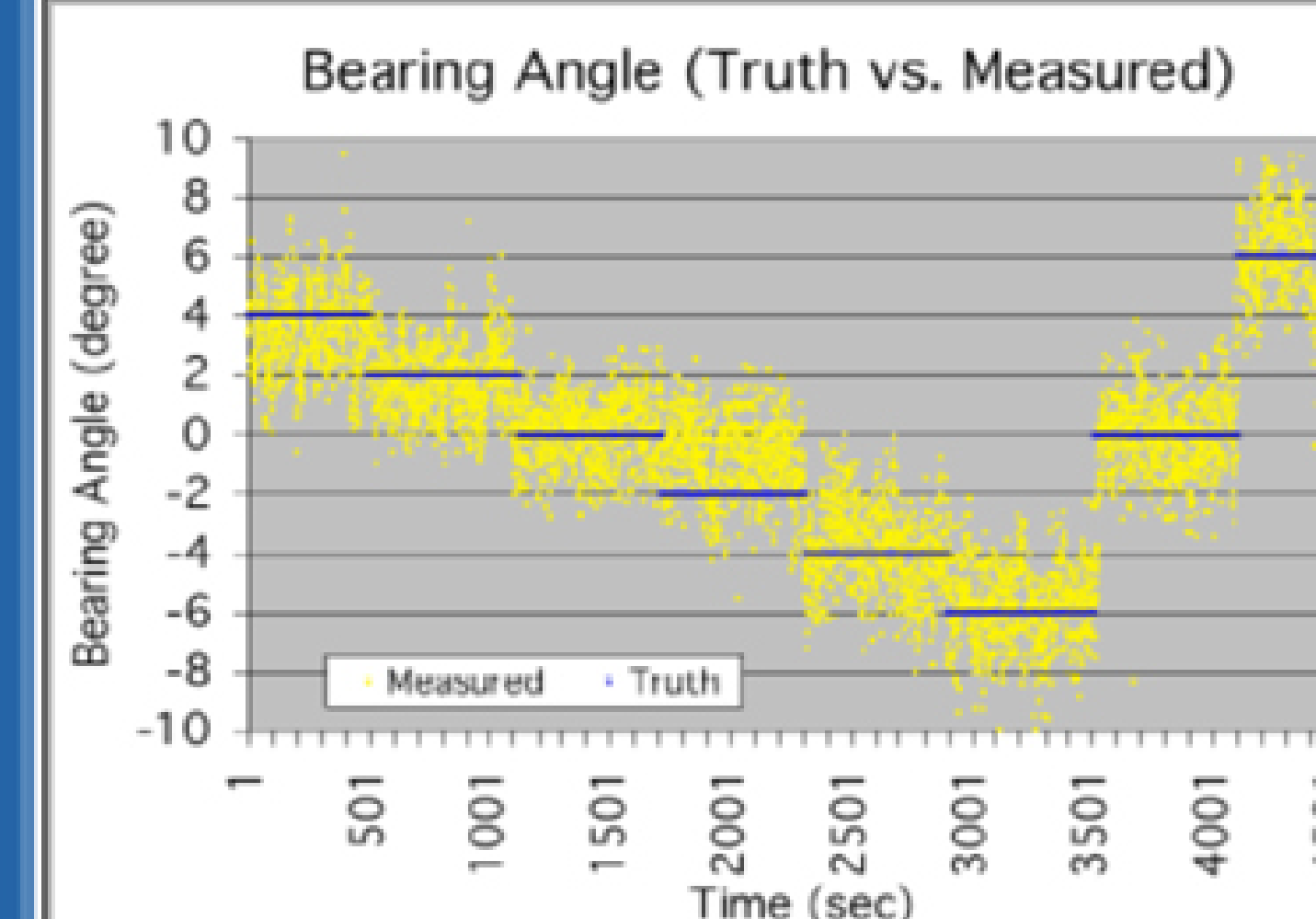
Preliminary Test Results

Objective:

To demonstrate the use of new signal structure to get absolute bearing angle measurement without the need for spacecraft rotation calibration maneuver. (Previous year in AFF: relative bearing angle, otherwise, calib. maneuver needed)

Requirement:

- Accuracy: < 5 degree bearing angle



JPL Mesa Antenna Test Range

Summary Results:

- Bearing accuracy: < 2 degrees
- Bearing precision: ~ 1 degree (1σ)

Benefit for TPF:

- Significant reduction in flight system design and operational complexity.